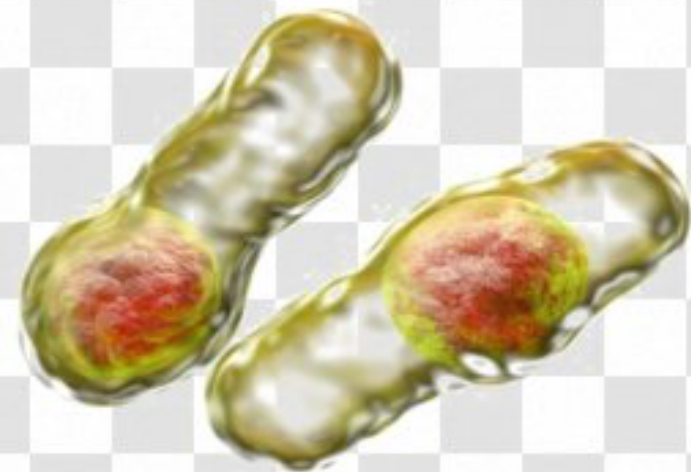
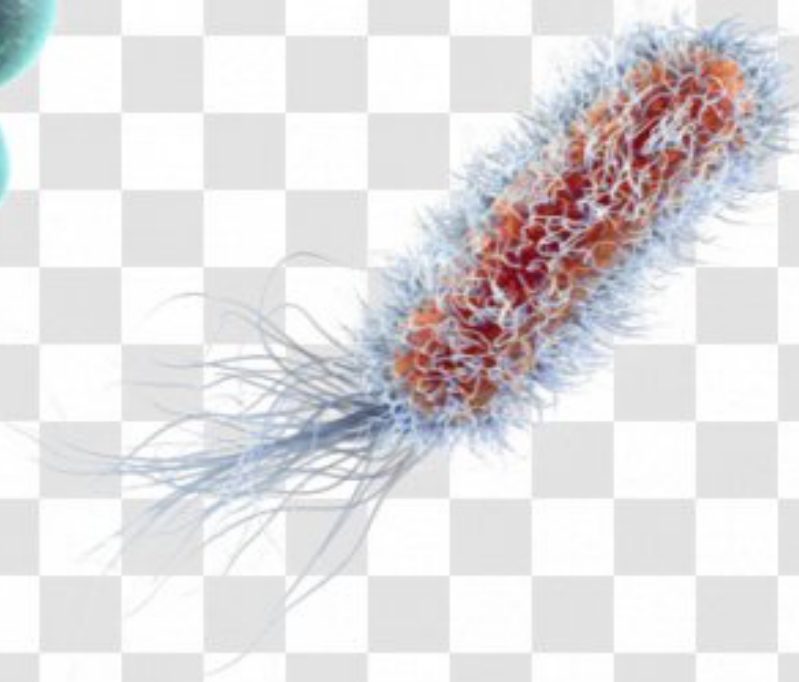
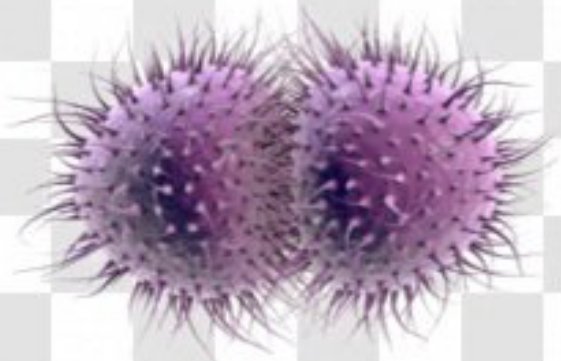
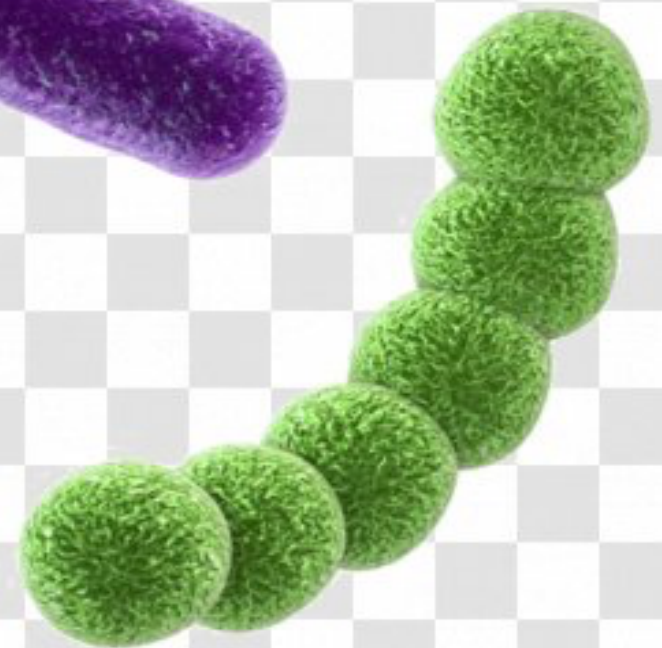
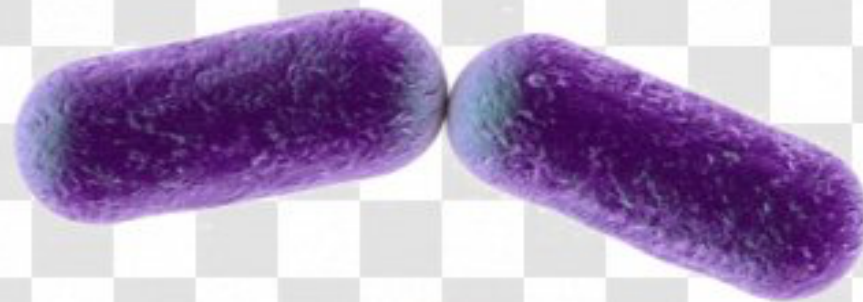
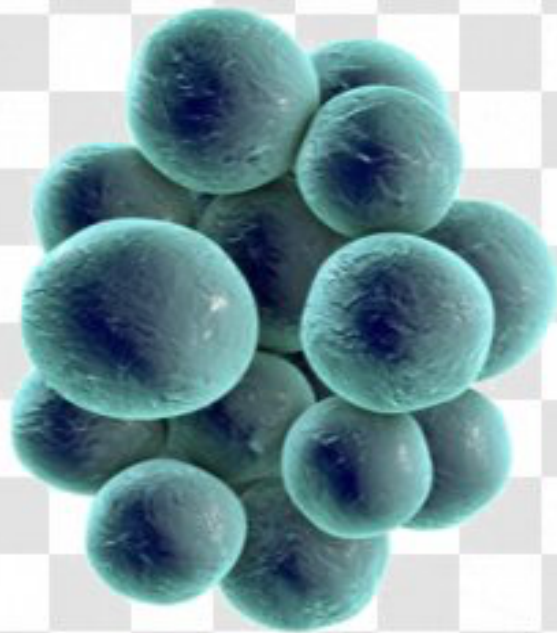


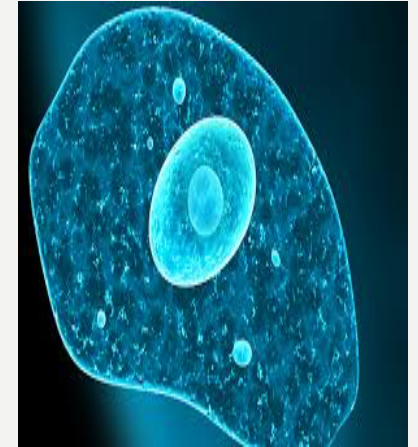
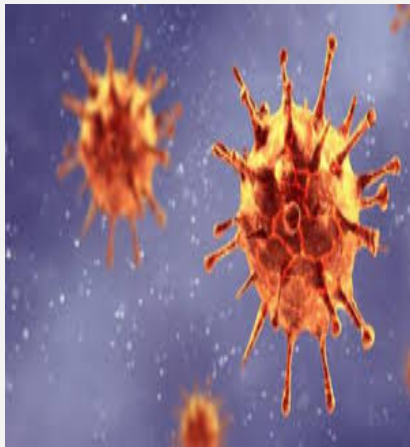
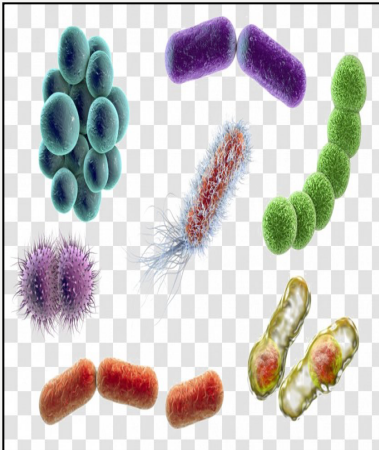
# *MICROBIOLOGY*

*BACT: 201*

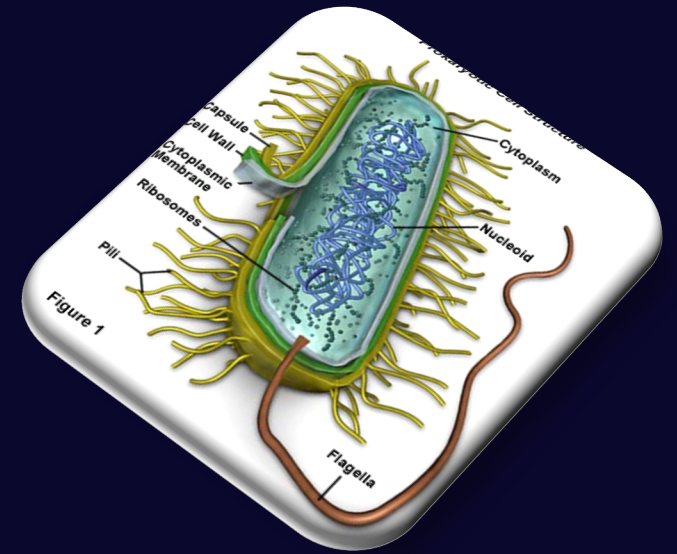
*DR. BASMA SAMIR (MD)*



**Microorganisms** include bacteria, viruses, fungi, prions, protozoa and algae, collectively known as 'microbes'.



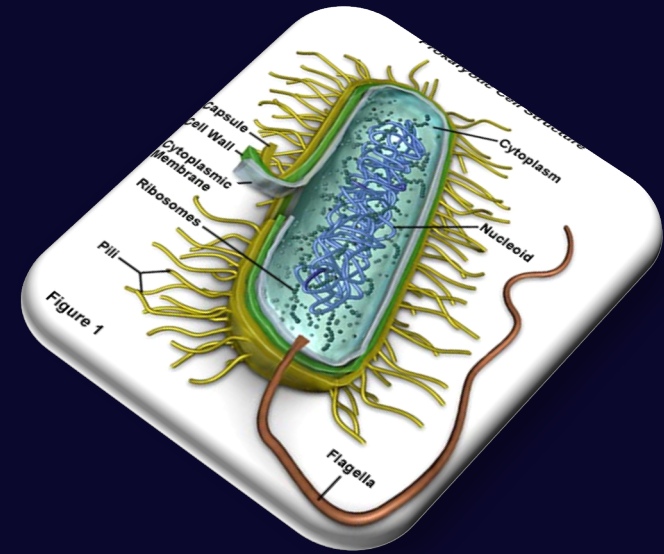
# BACTERIA



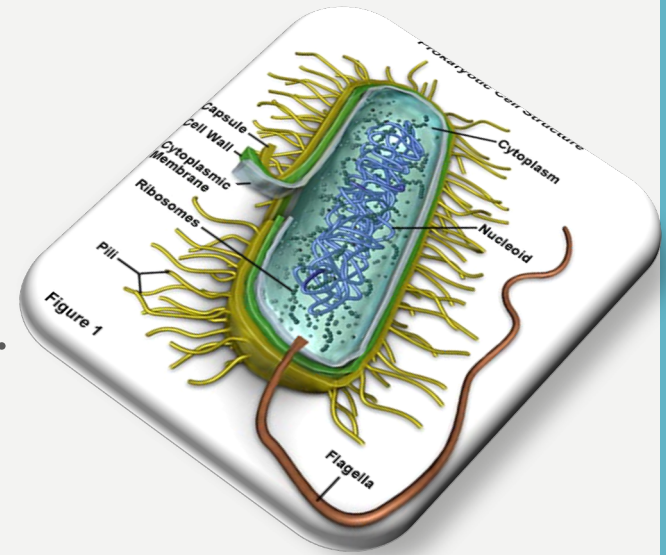
- Bacteria are found in **every habitat on Earth**: soil, rock, oceans and even arctic snow.
- Some live **in or on** other organisms including plants and animals including humans.
- A lot of these bacterial cells are found lining the digestive system.
- Bacterial species that lives symbiotically in the large intestine **manufactures vitamin K**, an essential blood clotting factor.
- They make it possible for animals (cows, sheep, goats) to **digest plant cellulose**. and to **convert nitrogen to a more usable form** for some plants (soybean, peas, alfalfa).

- Some bacteria live in the soil or on **dead plant** matter where they play an important role in the **cycling of nutrients**.
- Some types cause **food spoilage and crop damage** but others are incredibly useful in the **production of fermented foods** such as yoghurt and soy sauce.
- **Some bacteria are pathogens** that can cause disease in animals and plants.

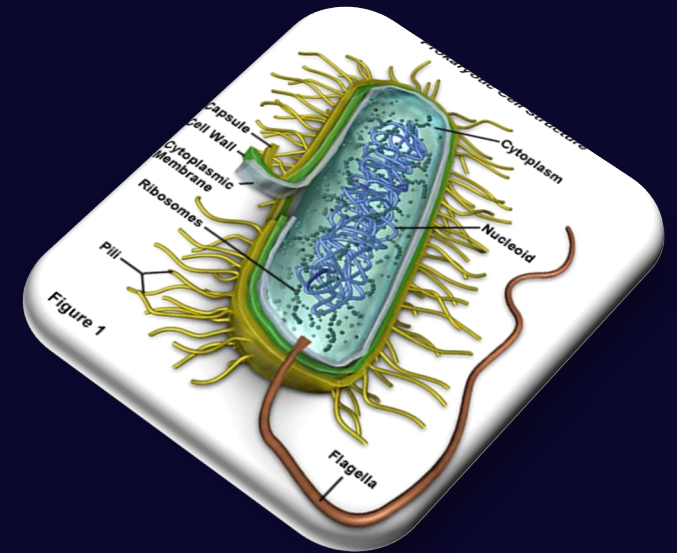
# CHARACTERISTICS OF BACTERIA



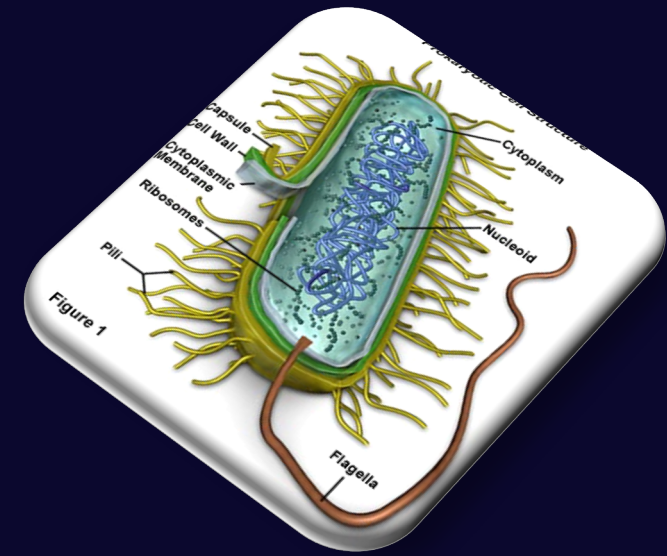
- Bacteria are prokaryotes, **single** celled microbes.
- **Very small** that they can only be seen with a microscope.
- Cell structure **is simpler** than that of other organisms.
- They **lack well-defined nuclei** and membrane-bound organelles.
- Genetic information is contained **in a single loop of DNA**.
- Some bacteria have an extra circle of genetic material called a **plasmid**.
  - The plasmid often contains genes that give the bacterium some advantage over other bacteria. *For example it may contain a gene that makes the bacterium resistant to a certain antibiotic.*



# CLASSIFICATION OF BACTERIA



- There are different ways to classify bacteria.
- They can be divided into three types based on their response to gaseous oxygen.
  - **Aerobic bacteria** require oxygen for their health and existence and will die without it.
  - **Anerobic bacteria** can't tolerate gaseous oxygen at all and die when exposed to it.
  - **Facultative anaerobes** prefer oxygen, but can live without it.



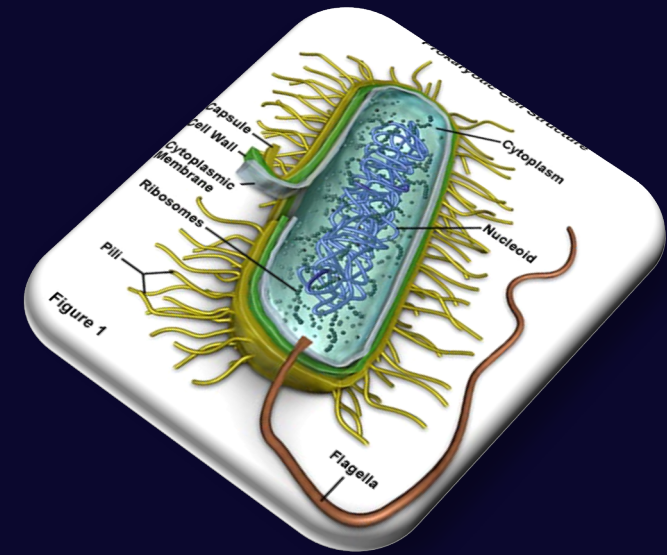
# Oxygen Consumption

- The second way of grouping them is by how they obtain their energy.

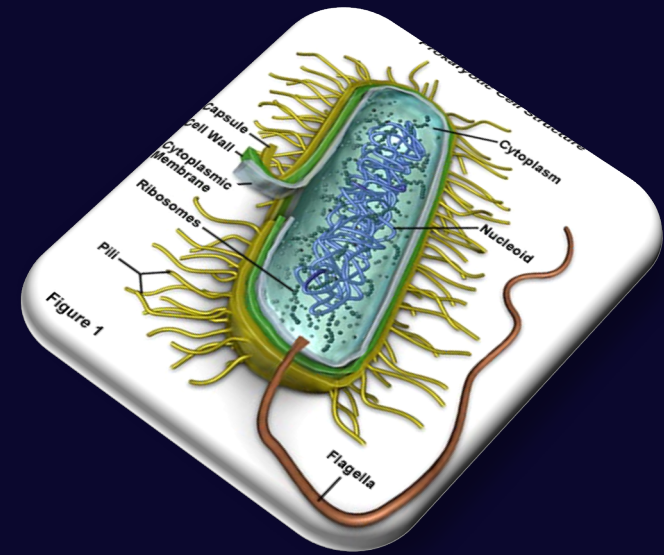
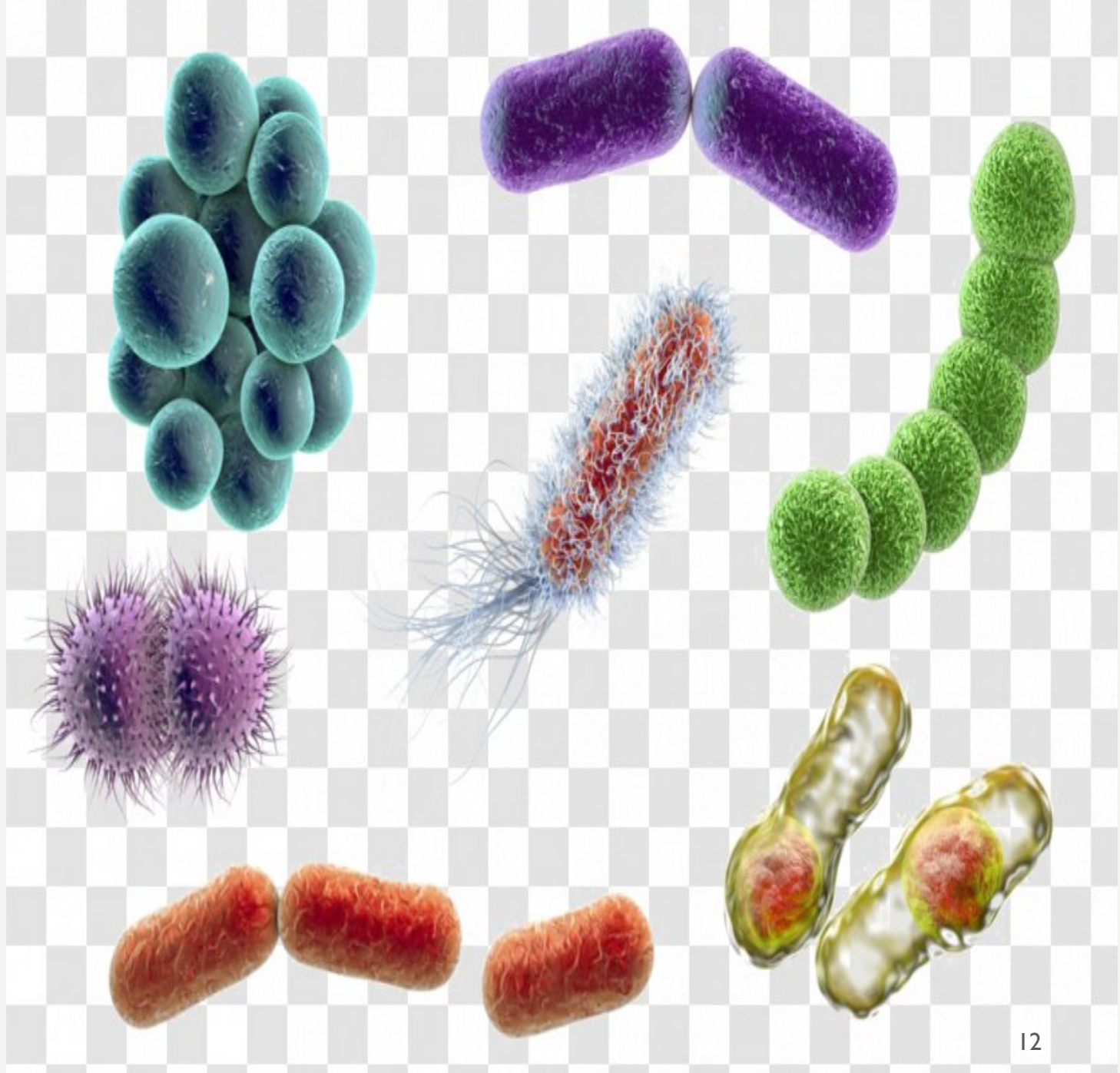
- **Heterotrophs:** Bacteria that have to consume and **break down complex organic compounds.**

This includes species that are found in decaying material as well as those that utilize fermentation or respiration.

- **Autotrophs:** Bacteria that **create their own energy,** depending on light or through chemical reactions.



## *Energy Source*

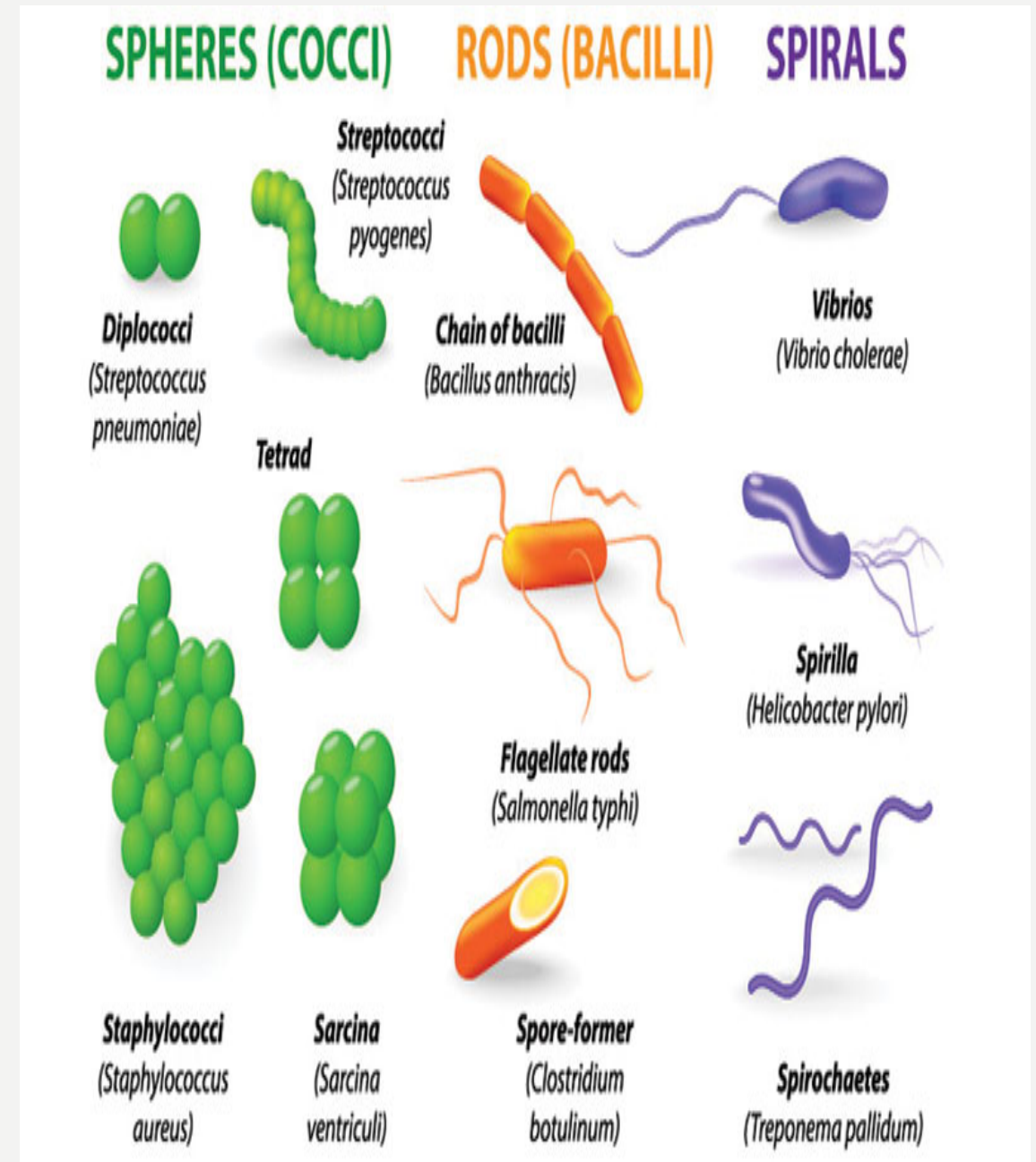


# Morphology

Bacteria are classified into **Five main** groups according to their basic shapes:

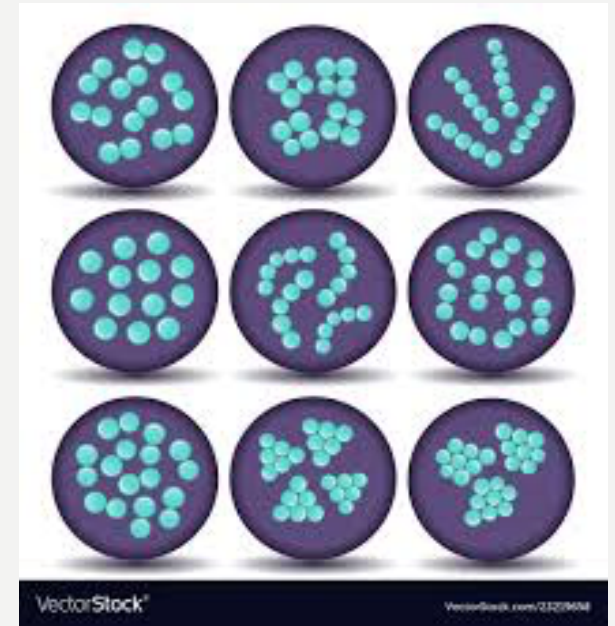
- Spherical (cocci),
- Rod (bacilli),
- Comma (vibrios)
- Spiral (spirilla), or
- Corkscrew (spirochaetes).

They can exist as single cells, in pairs, chains or clusters.



# COCCI

- These are round bacteria measuring about 0.5–1.0  $\mu\text{m}$  in diameter.
- When multiplying, cocci may form pairs, chains, or irregular groups:
  - Cocci in pairs are called diplococci, e.g. meningococci and gonococci.
  - Cocci in chains are called streptococci, e.g. *Streptococcus pyogenes*
  - Cocci in irregular groups are called staphylococci, e.g. *Staphylococcus aureus*.



# BACILLI

- These are rod-like bacteria. They measure 1–10  $\mu\text{m}$  in length.
- Bacterial rods may:
  - form **chains**, e.g. *Streptobacilli*.
  - form **branching chains**, e.g. *Lactobacilli*.
  - **mass together**, e.g. *Mycobacterium leprae*.
  - **remain attached at various angles** resembling Chinese letters, e.g. *Corynebacterium diphtheriae*.
- Many rods are motile having a single flagellum, or several flagella, at one or both ends or surrounding the entire organism.



# VIBRIOS

- These are **small slightly curved rods** measuring 3–4  $\mu\text{m}$  in length.
- Most vibrios are **motile with a single flagellum at one end**.
- They show rapid motility, e.g. *Vibrio cholerae*.



# SPIRILLA

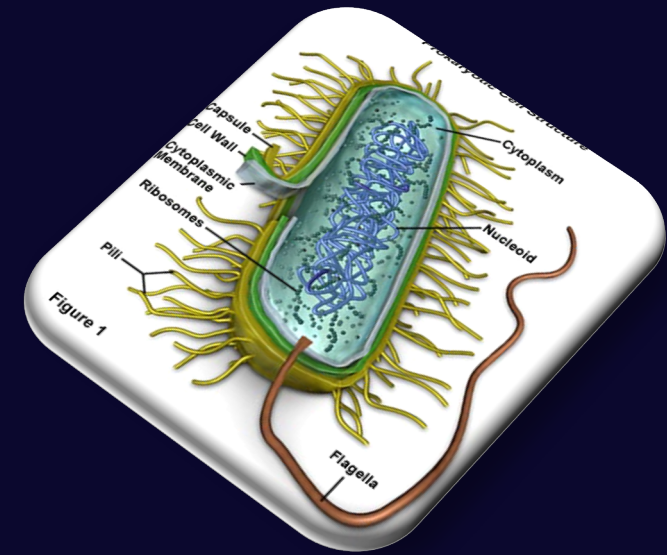
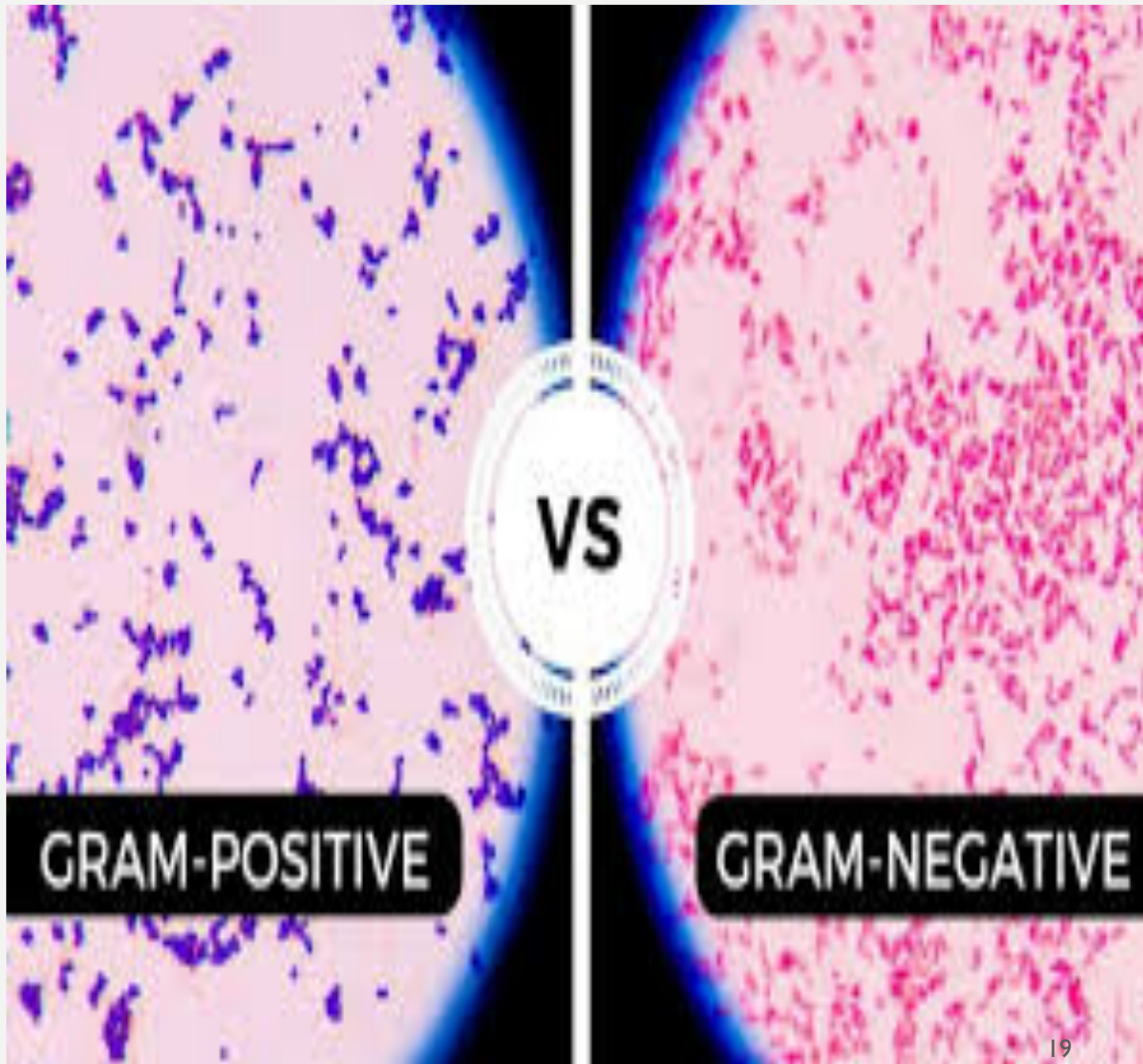
- These are small, regularly coiled, **rigid** organisms measuring about 3–4  $\mu\text{m}$  in length.
- Spirilla are **motile with groups of flagella at both ends**.



# SPIROCHAETES

- These are **flexible, coiled, motile organisms**.
- They progress by rapid body movements.
- Spirochaetes are divided into main groups:
  - **Treponemes**
    - Examples include *Treponema pallidum*.
  - **Borreliae**
    - Examples include *Borrelia vincenti*.
  - **leptospires,**
    - Leptospire of medical importance is *Leptospira interrogans*.
  - **Gram negative Spirochaetes**
    - *Helicobacter pylori*

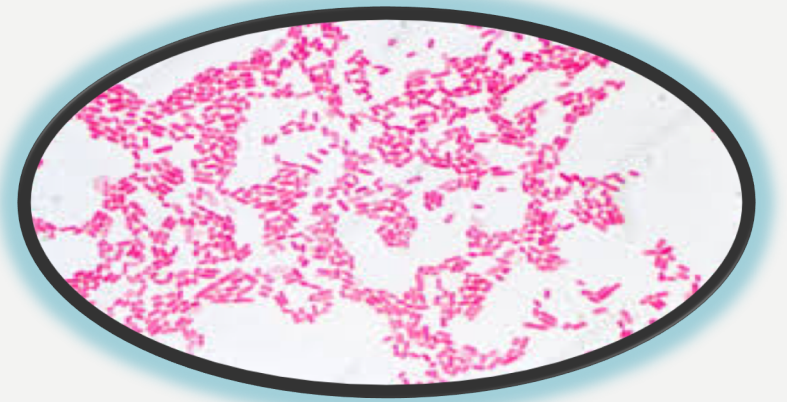
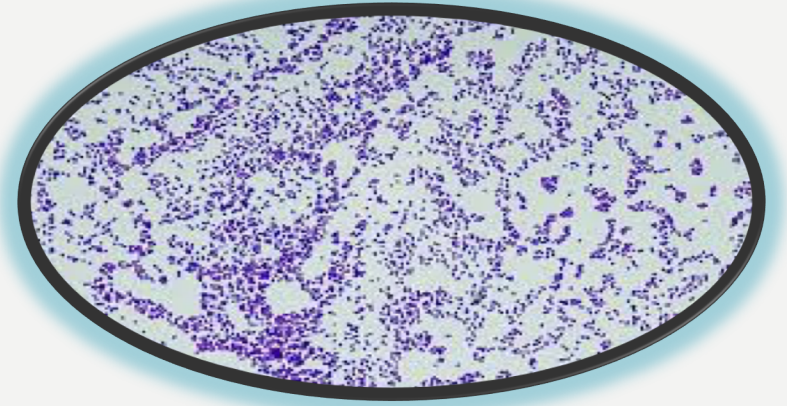




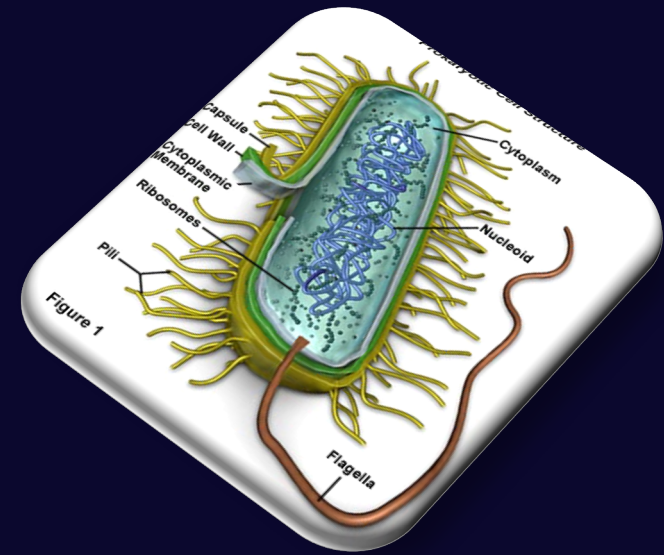
# *Gram Stain*

- Gram staining is **almost always the first step** in the preliminary identification of a bacterial organism.
- The name comes from the **Danish Bacteriologist Hans Christian Gram**, who developed the technique.
- It is a laboratory method used to distinguish and classify Bacterial species **into two large groups: gram-positive bacteria and gram-negative bacteria.**
- Gram staining differentiates bacteria by the chemical and physical properties of their cell walls.

- Gram-positive cells have a **thick layer of peptidoglycan** in the cell wall that retains the primary **Violet** stain.
- Gram-negative cells have a **thinner peptidoglycan** layer that allows the crystal violet to wash out on addition of ethanol.
  - They are stained **Pink** or red by the counterstain.



# BACTERIAL CELL STRUCTURE

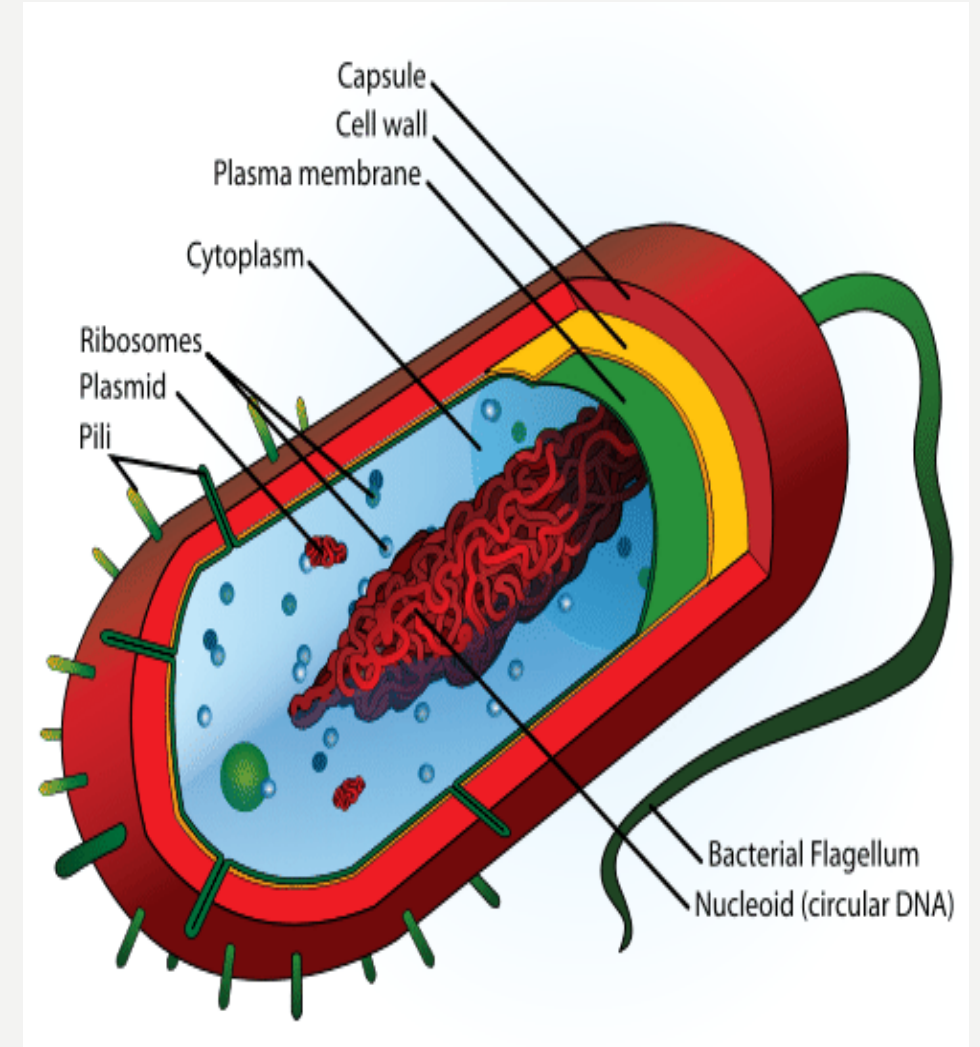


# CELL ENVELOPE

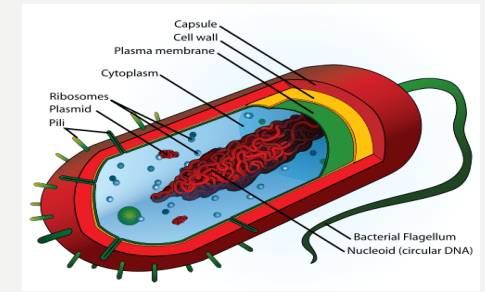
The cell envelope in a bacterial cell encases the cytoplasm and all its components.

The cell envelope is made up of two layers:

1. Cytoplasmic (Plasma) membrane
2. Cell wall

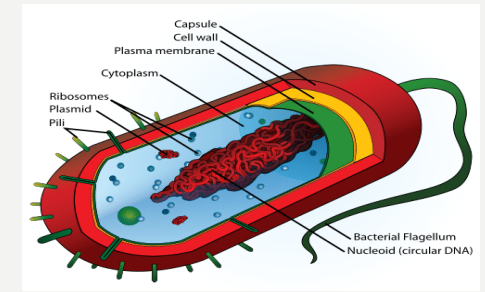


# PLASMA MEMBRANE



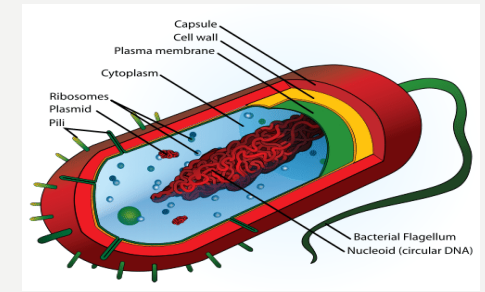
- A layer of phospholipids and proteins, called the plasma or cytoplasmic membrane, encloses the interior of the bacterium, **regulating the flow of materials in and out of the cell.**
- A **barrier that allows them to selectively** interact with their environment.
- Membranes are highly organized.
- Membranes are also dynamic, constantly adapting to different conditions.

# CELL WALL



- **Each** bacterium is enclosed by a rigid cell wall composed a peptidoglycan molecule. (consists of sugars and amino acids).
- The wall **gives the cell its shape** and surrounds the cytoplasmic/plasma membrane, **protecting it** from the environment.
- It also helps to **anchor appendages** like the pili and flagella, which originate in the cytoplasm membrane and protrude through the wall to the outside.
- The strength of the wall is responsible for **keeping the cell from bursting** when there are large differences in osmotic pressure between the cytoplasm and the environment.

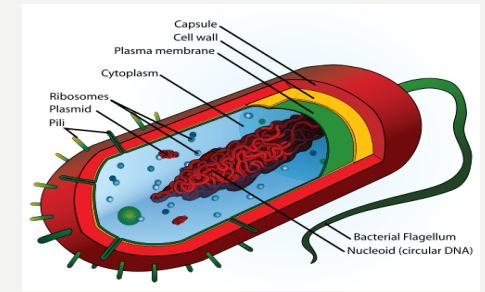
# CAPSULE



- **Some** species of bacteria have a **third protective covering**, a capsule made up of polysaccharides (complex carbohydrates).
- Capsules play a number of roles, but the most important are
  - to keep the bacterium from drying out and
  - to protect it from phagocytosis (engulfing) by larger microorganisms.

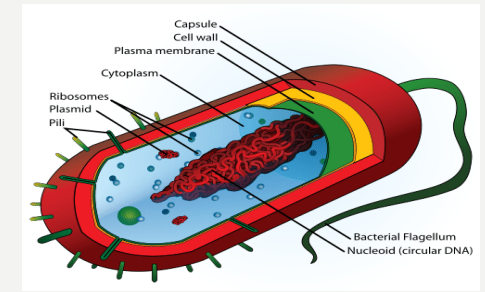
The capsule **is a major virulence factor in the major disease-causing bacteria**, such as *Escherichia coli* and *Streptococcus pneumoniae*.

# CYTOPLASM



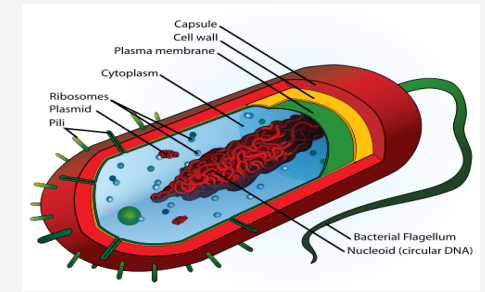
- The cytoplasm, or protoplasm, of bacterial cells is where the **functions for cell growth, metabolism, and replication are carried out.**
- It is a gel-like matrix composed of water, enzymes, nutrients, wastes, and gases.
- It contains cell structures such as
  - **Mitochondria, Ribosomes, One chromosome, and Plasmids.**
- Unlike eukaryotic (true) cells, bacteria do not have a membrane enclosed nucleus.
- The **chromosome**, a single, continuous (circular) strand of DNA, localized, in a region of the cell called the nucleoid.
- All other cellular components **are scattered** throughout the cytoplasm.

# NUCLEOID



- The nucleoid is a region of cytoplasm where chromosomal DNA is located.
- Most bacteria have a single, **circular chromosome that is responsible for replication**, although a few species do have two or more.
- Only the chromosome has the genetic instructions for initiating and carrying out cell division, or binary fission, the primary means of reproduction in bacteria.

# PLASMIDS

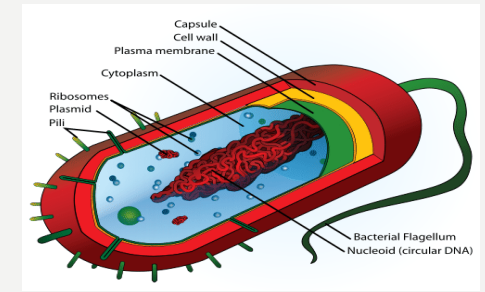


- Small, extrachromosomal **genetic structures** carried by many strains of bacteria.
- Like the chromosome, plasmids **are made of a circular piece of DNA.**
- Unlike the chromosome, plasmids **are not involved in reproduction.**

# PLASMIDS

- Plasmids help in the **transmission of special properties**, such as
  - antibiotic drug **resistance**,
  - **resistance** to heavy metals, and
  - **virulence factors** necessary for infection of animal or plant hosts.
- *The ability to insert specific genes into plasmids have made them extremely useful tools in the fields of molecular biology and genetics, specifically in the area of genetic engineering.*

# RIBOSOMES

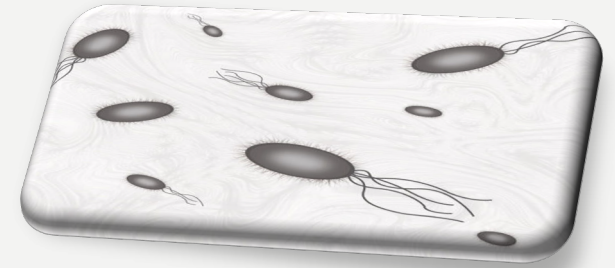


- Microscopic "factories" found in **all cells**, including bacteria.
- They translate the genetic code of nucleic acid in chromosomes to amino acids; the building blocks of proteins.
- **Proteins** are the molecules that **perform** all functions of cells and living organisms.
- Bacterial ribosomes **are smaller** and have a slightly different composition and molecular structure to those of eukaryotes,.
- Bacterial ribosomes **are never bound** to other organelles, but are free structures distributed throughout the cytoplasm.
- There are **sufficient differences** between bacterial ribosomes and eukaryotic ribosomes that **some antibiotics will inhibit** the functioning of bacterial ribosomes, but not a eukaryote's, thus killing bacteria but not the eukaryotic organisms they are infecting.

A decorative graphic on the left side of the slide consisting of two parallel, wavy lines. The inner line is a light blue color, and the outer line is white. They follow a similar undulating path from the top left towards the bottom left.

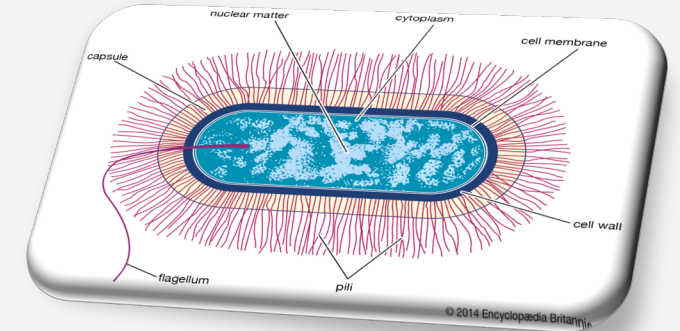
# **EXTERNAL STRUCTURES**

# FLAGELLA



- **Flagella:** (singular, flagellum)
- They help bacteria **move**. They are hair-like structures that provide a means of locomotion for those bacteria that have them. As the flagella rotate, they spin the bacteria and propel them forward.
- They can be found at one end or both ends of a bacterium or all over its surface.
- The flagella help the bacterium move
  - toward nutrients,
  - away from toxic chemicals, or
  - toward the light in some bacterial species.

# PILI

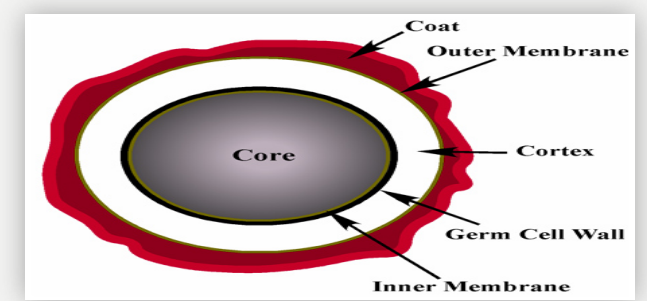


- Many species of bacteria have pili (singular, pilus).
- Small hair-like projections emerging from the outside cell surface.
- These outgrowths assist the bacteria in **attaching** to other cells and surfaces, such as teeth, intestines, and rocks.
- Without pili, many disease-causing bacteria lose their ability to infect because they are unable to attach to host tissue.



# **SOME PROTECTIVE MEASURES**

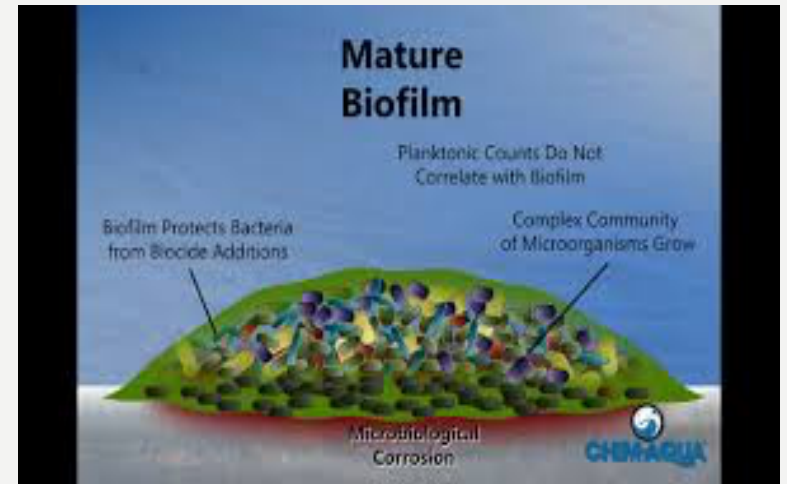
# ENDOSPORES



- Some bacteria can form endospores by forming a highly resistant cell to preserve the its genetic material when favored environmental conditions are changed and become hostile, such as heat, UV radiation and disinfectants.
- The completed endospore is a dormant structure that consists of multiple layers of resistant coats (including a cortex, a spore coat) surrounding a nucleoid, some ribosomes, RNA molecules, and enzymes.
- This makes destroying them very difficult.
- Many endospore-producing bacteria are nasty pathogens, for example *Bacillus anthracis*, the cause of anthrax.

# BIOFILM

- Some bacteria secrete a substance that helps them **attach to other** bacteria, cells, or objects.
- This substance combines with the bacteria to form a **sticky layer** called biofilm.
- For example, certain bacteria form a biofilm on teeth (called **dental plaque**).
- The biofilm traps food particles, which the bacteria process and use, and in this process, they probably cause tooth decay.
- Biofilms also **help protect bacteria from antibiotics**.



# DISCUSSED TOPICS

- **Bacteria abundance in Ecosystem of Planet Earth and their importance to Life and Man.**
- **Bacteria Characteristics**
- **Classification of Bacteria according to:**
  - **Oxygen Consumption**
  - **Energy source**
  - **Morphology**
  - **Gram stain**
- **Bacterial Cell Structure**
- **External Structures**
- **Some Protective Measures of Bacterial Cells.**

# Thank You

